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TITLE BUILDING AN ARTIFICIAL INTELLIGENCE CAPABILITY AT LOS ALAMOS

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at the
"Artificial Intelligence Applications for Military Logistics Conference"
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I. INTRODUCTION

In 1985, after three years of preliminary work, Management of the Los Alamos National Laboratory started an ambitious program to develop a strong technical capability in the rapidly emerging field of Artificial Intelligence/Knowledge Based Systems (AI/KBS).

When this AI development program began, except for a few staff members doing basic AI research, AI was essentially nonexistent at the laboratory. The basics, including such things as AI computer hardware and software, literature, books, knowledgeable personnel, or even a general knowledge of what AI was, were most difficult if not impossible to find. For this reason, we had to approach the problem with a very broad perspective, which strongly addressed the basics while aiming toward more advanced AI program elements. Broad, intensive education was the "bootstrapping" tool used in this five year, multi-million dollar AI capability development program.

Halfway through the program, our accomplishments indicate that the program is extremely successful. In terms of trained staff, active programs and "state-of-the-art equipment," we have developed one of the strongest AI technical capabilities within the Department of Energy (DOE) and the Department of Defense (DOD). However, a great deal more must be done before the full potential of the program can be realized.

II. PROGRAM OBJECTIVES

The main program objective is to develop a strong scientific and technical capability in the field of Knowledge Based Systems/Artificial Intelligence. That is, to increase the technical capability of the Laboratory by educating good individuals to be better, without increasing the total staff level of the Laboratory. This objective is to be accomplished through education, individual support, organization development, project applications and research.

Specific Objectives (Program phases, see Fig. 1)

1. Build and equip an AI education facility (now called the Knowledge Systems Laboratory or KSL). Develop a fully integrated, four-month, total immersion course of education. Educate a critical mass (30-60) of selected Los Alamos people in the KBS/AI field.

2. Upon completion of the course, support the graduates with KSL resources, expertise and peer interaction for the necessary 1-2 years of reinforcing the formal education by doing.

3. Enhance the KBS/AI support environment at Los Alamos through further Laboratory "organization development" such as a dedicated AI Library, improved facilities, seminars, colloquia, management and staff education, etc.

4. Decrease emphasis on education, make the transition to research and application projects and shift AI funding from internal support to outside self-supporting projects.

5. Maintain a vigorous and continuous effort to keep abreast of the field and maintain quality of staff members.

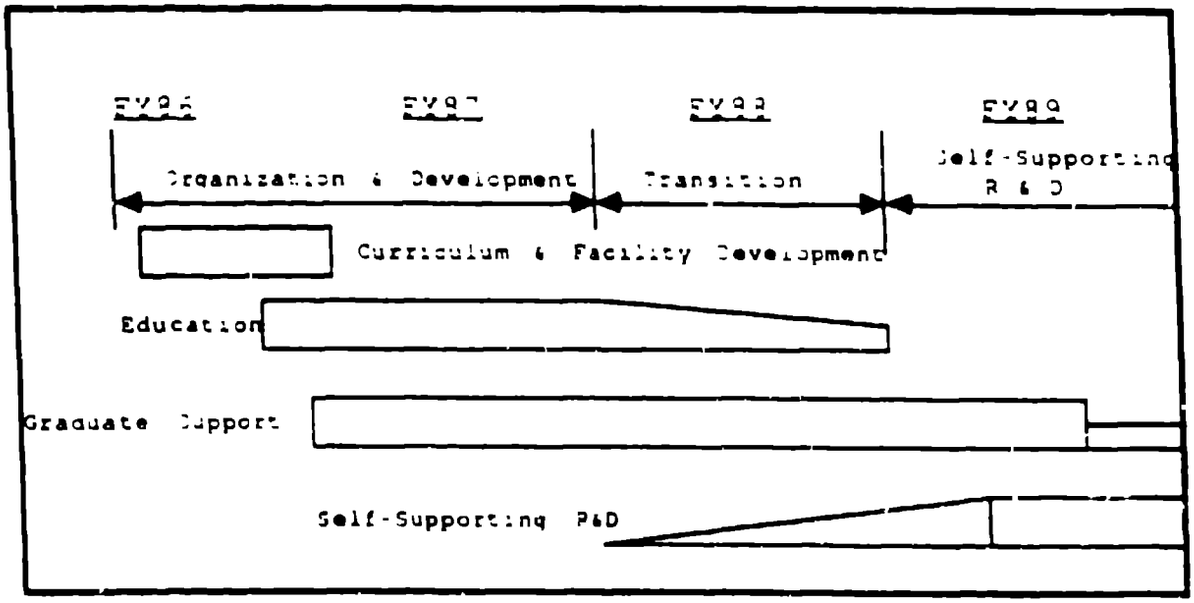

Figure 1

III. ACCOMPLISHMENTS AND PROGRAM STATUS

Although the second half of the program has just begun, a great deal has been accomplished for the Laboratory.

The Knowledge Systems Laboratory (KSL)

A 4400 square foot training and development area called the Knowledge Systems Laboratory (KSL) was constructed. The KSL is equipped with approximately one million dollars worth of the most advanced AI computer hardware and software and is capable of supporting approximately 28 staff members. The KSL is also equipped with a select AI library of periodicals, texts, reports and video programs for the education and support of all Laboratory staff.

Course Curricu

A unique 5(our a week, total immersion, four month education course was developed. This cou. se is directed toward helping staff members to develop at many levels of AI depending upon their individual needs and objectives. A goal of the program was to accelerate the transitio n of educated professionals into the AI field by compressing two to three years of educatio n by normal means into a period of four months.

In the course, theory and fundamentals (50%/425 hrs) are stressed as well as practice and tools (40%/350 hrs). The remainder of the course focused on "real world" issues such as program management, societal impact, world programs, future trends, etc... It is intended that the course be followed by one to two years of learning by doing. Presentation of the course material involved instructors and consultants from the Laboratory, universities, research centers, Government and private industry.

KSL Graduates

A total of 45 students completed the four-month course. Three courses were given, the last course ended on September 25, 1987. The classes included 35 students from 16 Laboratory Divisions, 4 from the Sandia National Laboratory, 2 from the DOE Bendix plant, 2 from the U.S. Army (currently assigned to Los Alamos), 1 from the Oak Ridge Y-12 Plant and 1 from the Lawrence Livermore National Laboratory.

In theory, all the students were temporarily relieved of their normal work in order to attend the class. Students from outside the Laboratory were relocated to Los Alamos for four months. A condition for enrollment was that upon graduation the management of each student would continue to support the student in AI work for a necessary "learning by doing" period of about 1 1/2 years.

Students were selected on the basis of (1) a demonstrated interest in AI and a strong desire to enter the field and (2) the strong support and sponsorship of their management. They averaged about 37 years of age, came from a variety of professional fields and were well educated (see Table 1).

TABLE 1

KSL STUDENT PROFILE

AVERAGE AGE:	*37, RANGE 25-55*
EDUCATIONAL LEVEL:	*26% BACHELORS* *38% MASTERS* *36% DOCTORATES*

PROFESSIONAL BACKGROUND:

Chemical Engineering
Computer Engineering
Electrical Engineering
Geochemistry
Law
Mechanical Engineering
Nuclear Engineering
Physics
Chemistry
Computer Science
English
Geology
Liberal Arts
Mathematics
Nuclear Physics

Graduate Involvement in AI Projects at Los Alamos

Following is a partial list of AI related projects which presently involve KSL graduates. For most of these projects the KSL people are the only AI trained people working on the project. However, there are about an additional half dozen experienced, well trained staff members within the Laboratory who are, while not directly associated with the KSL program, playing leading roles in these and other AI projects at the Laboratory.

AI Related Project Name or Application Area

Accelerator Alignment
Accelerator Design
Accelerator Control
Accelerator Source Control
Automatic Beam Optics Control
CAD/CAM Hardware-Software Needs Analysis
DOE Nuclear Materials Production
Gamma Monitor Instrumentation
Geologists' Assistant
Graphics Advisor
Intelligent Clustering Assistant For Life Science Data
LAN Diagnostics Assistant
NATO Force Planner
Navy KBS Applied to Technology
Oil Refining Assistant
Project Feasibility Screening Assistant
Raid Electronic Support System
Simulation Tool For Weapon Analysts
Text to Audio English Reader
Tribology

Los Alamos AI Hardware and Software Capabilities

When Los Alamos set out to develop its AI capabilities in 1983, we did not have a single special purpose AI computer at Los Alamos and AI software was limited to a few unsupported low level languages. Today, Los Alamos' AI efforts are supported by approximately 45 LISP machines, 20 AI Sun machines, scores of PCs and about four VAX systems. In addition, we have approximately 50 high level AI development programs ($15-40K range), 35 medium level AI development programs ($5-15K range), and at least 100 PC based tools. These resources represent an investment of approximately four million dollars.

VI. CONCLUSION

The objectives of the AI Technology Development Program are most ambitious, involve many unknowns and entail a certain amount of risk. Nevertheless, we have every reason to believe that having come half way through the program, we have already been extremely successful.

We have significantly increased the capabilities of the Laboratory by enhancing the skills and capabilities of many of our staff. We have developed an impressive array of resources with which we can support these people in their work. We have built one of the strongest AI technical capabilities in the Federal Government. We have developed a strong competitive position in a most promising technical field that has already proven its value. This has been accomplished in two years without hiring a single additional staff member. And the Program has already paid for itself several times over in reimbursable new initiatives.

However, there is a great deal of work to be done in the next few years to improve and strengthen our AI capabilities. Los Alamos will continue to develop its AI abilities and expand this capability into other Laboratory mission areas.